

## 2<sup>nd</sup> Workshop on Tourism Monitoring in Antarctica - Development of a concept for the analysis of the impacts of tourism on the assets to be protected in the Antarctic

10 - 12 October 2023 (online), 13:00 - 16:00 CEST

### Summary

The second workshop on tourism monitoring was held to continue work on the development of a comprehensive concept for the analysis of the impacts of tourism and other non-governmental activities on the assets to be protected in the Antarctic. The current status of the monitoring concept was presented, and two keynotes provided valuable insights into existing monitoring approaches. Discussions focused on the monitoring possibilities via cruise ships, at landing sites, and from the distance. This workshop reports aims to give an overview of the remarks and ideas shared.

**We would like to thank everybody who participated in the workshop for the useful comments, documents, and projects you shared with us! We look forward to continuing our work towards the effective protection of the Antarctic environment together.**

### Background

#### Why is a comprehensive framework for monitoring the impacts of tourism in Antarctica needed?



Climate change expected to increasingly impact the sensitive Antarctic environment.



Rising tourist numbers and diversification of Antarctic tourism have the potential to have a (negative) impact on ecosystems or their individual components.



Impacts of tourism are considered to be *minor and transitory*, but the cumulative and long-term impacts of tourism activities in the Antarctic are poorly understood.



Lack of a comprehensive regulatory and management framework for tourism.

## Introduction

A solid knowledge base on the impacts of touristic and other non-governmental activities and the effectiveness of different management measures is the prerequisite for the proactive management of tourism in the Antarctic. The German Environment Agency (UBA) therefore commissioned a research project with funding from the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection to develop a systematic and comprehensive long-term monitoring concept for tourist sites in the Antarctic. The results of the monitoring should serve to prevent or minimize potential adverse impacts of touristic and other non-governmental activities and advance the protection of the Antarctic environment.

Relevant stakeholders from different domains (e.g., science, competent authorities, tourism industry and NGOs) are involved in the development of the monitoring concept from the beginning to ensure the practical relevance of the concept. Two workshops have been conducted in the course of the project:

The first workshop was held on 28 May 2022 in Berlin to set the baseline for the development of the monitoring concept. It aimed at reflecting the results from a literature review on the impacts of touristic and other non-governmental activities, defining the conceptual framework for the monitoring concept, and fostering cooperation among different stakeholders. The workshop report as well as background information can be downloaded from the workshop website<sup>1</sup>.

In the second workshop, an update on the status of developing the monitoring concept was provided. Participants discussed concrete monitoring possibilities and provided insights into ongoing projects and initiatives, which will be considered in the finalization of the monitoring concept. It took place from 10 - 12 October 2023 as an online event. The three-day workshop was thematically clustered as follows:

- Monitoring possibilities from distance (based on e.g. databases, PVRs, satellite data)
- Monitoring possibilities via ship
- Monitoring possibilities on land

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<sup>1</sup> <https://tourism-monitoring-antarctica1.fresh-thoughts.eu/materials/>

# Keynotes and Q&A

## Keynote 1

### Using citizen science projects for monitoring – experiences from practical examples (Annette Bombosch, *The Polar Citizen Science Collective*)<sup>2</sup>

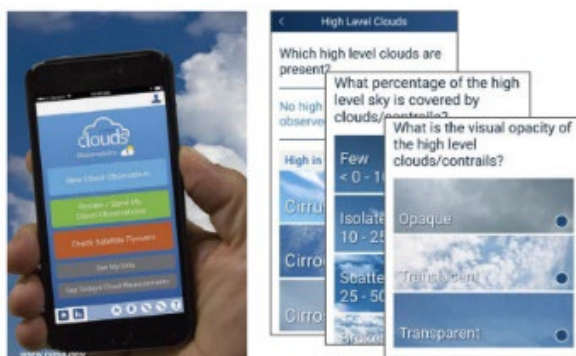
- Citizen Science = involvement of public in scientific research (in project design, data collection or data analysis)
  - Contribute to scientific research
  - Increases educational learning & scientific literacy
- Challenges: Polar regions are remote, Research time is limited, Geographic coverage is limited, Research is expensive → Utilize expedition cruise vessels as unique platforms of opportunity for research via Citizen Science
  - Increased spatial & temporal coverage
  - Reduced costs
  - Increased science outreach
- Example 1: Happywhale (<https://happywhale.com/home>)
  - How it works:

**1 Set** Set your camera to the local date and time. Turn on GPS if you've got it!

**2 Photograph** Capture as many photos as you can clearly showing the ID features of the subject

**3 Submit** Go to happywhale.com and upload all photos for each animal. For new users, an account will auto-generate.

- Contribution to science & management → Resulted in the publication of several scientific papers and the introduction of Slow Down Zones to avoid ship-strikes
- Example 2: GLOBE Clouds (cloud observations for NASA in the polar regions, see <https://observer.globe.gov/do-globe-observer/clouds>)



<sup>2</sup> The presentation can be downloaded at <https://tourism-monitoring-antarctica2.fresh-thoughts.eu/materials/>.

- Example 3: Beetles vs. Stones  
(Tracking invasive beetles in South Georgia, currently in test phase, see <https://polarcollective.org/projects>)
- Success factors:
  - Simple
  - easy & robust data protocol
  - Easy to use & affordable equipment
  - Education & learning opportunities
  - Feedback
  - Advance scientific knowledge
- Limitation
  - Project complexity (Specialized data protocols, extended time for data collection, extensive/delicate equipment)
  - Not suitable for all project topics
  - Only visited sites are surveyed
- Outlook:
  - Unique platforms of opportunity (Large amount of data collection possible, extended spatial & temporal coverage, reduced costs)
  - General willingness of operators, guides and travellers to make positive impact & contribute to protection of Antarctica together



## Q&A:

- Are there successful projects which are not app based?
  - Yes, some projects work with paper sheets but projects are moving towards apps (because it's more practical and easier to get the data)?
  - Some projects collect samples, e.g. FjordPhyto (see Discovering Antarctica's Invisible Forest with FjordPhyto - NASA Science) (which is logistically more complex and needs to be engaging, include feedback and fit into the itinerary of the operator)
- Who pays for establishing the projects?
  - Funding by the scientists, sometimes supported by the operators
  - Citizen Science adds value to the journey and for most guests it is a way to remain connected to Antarctica
  - At Viking, Guests pay for the science program (costs are modest compared to the overall costs of the voyage)
- Are there any issues for the scientists in keeping up with the volume of data generated?
  - Happy whale: a lot of data, Data goes to bigger data bases so it is available to more scientists
  - When projects are scaled up, we need to find ways of data storage and access
- To what extent is scaling up projects a limiting factor? What do you see as the biggest opportunities to develop the connections between citizen science and monitoring into the future? And what sort of input might be useful from scientists in this regard?
  - Depending on the data, opportunity to collect baseline data
  - Operators/field guides are the first ones to recognize changes
  - the tourism industry can help scientists with data collection consistently throughout the entire season

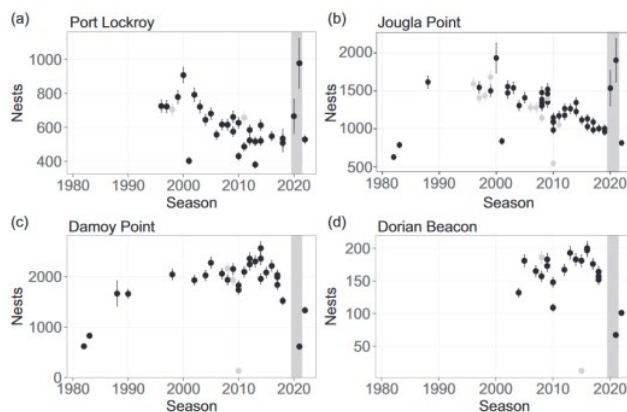
- Willingness of tourists to participate in citizen science projects?
  - Participation is not a problem to implement the projects successfully
- The issue of where data sits (and how available it is) and how capacity to process the data is provided are important questions for many researchers!
  - In Polar Regions: data needs to be shared, but depending on the project design, scientists are responsible
  - Viking: vast majority of funding is needed for the off-ship costs (data analysis etc.), not the on-ship costs
- How do the projects account for differences in data collection intensity, e.g. changing numbers of participants from year to year? It might be hard to use the data to measure change over time (e.g. in abundance of species)?
  - Robust designs are needed (enough data to get the right trends even if data is collected slightly different every time), design citizen science projects in a way to address this

## Keynote 2

### Possible field methods to monitor tourism impact on the Antarctic environment

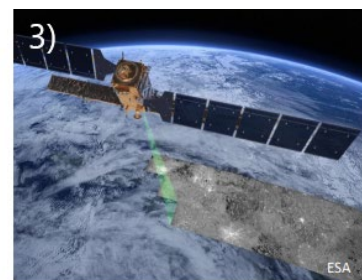
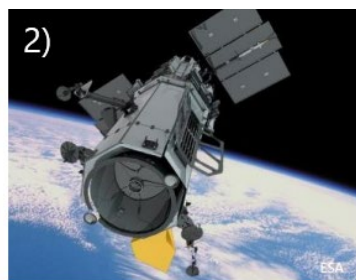
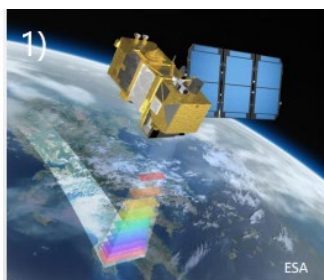
(Osama Mustafa, *ThINK - Thuringian Institute of Sustainability and Climate Protection*)<sup>3</sup>

- Example: analysis of the number of breeding gentoo Penguins around Port Lockroy (frequently visited tourist site, almost no visitation during Covid); result: in the frequently visited area the number of breeding penguins was rising while in the more distant parts it was decreasing  
→ human presence has an impact on the breeding behavior in that site



Flynn, C. M., Hart, T., Clucas, G. V. & Lynch, H. J. (2023): Penguins in the anthropause: COVID-19 closures drive gentoo penguin movement among breeding colonies. *Biological Conservation* 286: 110318. <https://doi.org/10.1016/j.biocon.2023.110318>

- Remote sensing technologies: **satellites**



<sup>3</sup> The presentation can be downloaded at <https://tourism-monitoring-antarctica2.fresh-thoughts.eu/materials/>.

1) medium resolution satellites, 2) high resolution satellites, 3) radar satellites

- Remote sensing technologies: **drones**



→ drone images are more detailed, but need more effort and local presence (e.g. flight planning, building a Digital Surface Model (DSM), analysing the data, ...)

- Drone and satellite imagery can be used to observe animal populations.
  - Different results depending on the phase of breeding phenology → timing is important
  - Single shots/oblique images are not very useful for monitoring wildlife colonies because you only cover a very small area
- Detecting vehicle tracks in ice surfaces (with medium-resolution satellites) and ice-free surfaces (with high-resolution satellite or drones), highly frequented tracks by visitors (trampling) are only visible in drone imagery and single tracks are hard to see



- Disturbance experiments: impacts of drones on penguin behavior was studied, but what about impacts of approaching persons, are there habituation effects → only a few studies
- **Remote cameras:** useful for long-term monitoring of penguin colonies, to get information about the breeding phenology; timelapse series of images → could also be used at tourist landing sites, what changes through the visitation? (experience with cameras also in the CCAMLR network)
- **Photo documentation:** information about long-term changes through repeated photos of a predefined section of a site, or focus on e.g., the occurrence of alien species or littering (take the photo and provide geoinformation data, time, etc.) → databases are needed to compare and analyse the data efficiently
- **Sampling:** pollution of air, water, soil; microorganisms etc.; but: trained personnel needed, permits, logistics for transport of samples, etc .

## Summary:

How?	What?	Who?
MedRes Satellites	Penguin colonies (rough estimate)	Expert off-site
HighRes Satellites	Penguin colonies (estimate)	Expert off-site
Drones	Colonies of birds, seals, tracks, erosion, waste	Expert on-site, (trained operator personnel)
Disturbance experiments	Changes in animal behaviour near landing sites	Experts on-site
Remote cameras	animal behaviour/distribution before and after tourist presence	Operator personnel
Ground photographs	alien species, pollution, litter/waste, oil spill, diseased animals	Operator personnel
Sampling	Pollution, Patoghens, intra- & interregional species transfer	Expert on-site

## Q&A:

- Is there a minimum height below which the drone flight starts to disturb the penguins?
  - Minimum height is depending on the species; need to fly very high to have only little disturbance effects.
  - 100 m is a good height where you have little disturbance effects and still the data quality is good enough.
- Do you need to be directly above the colony in order to get the images to produce the mosaics?
  - overlapping of the images is important, no gap between the images, otherwise it hides some parts of the area.
  - Oblique images: topography hides parts of the area, and the pixel size is different in the background and foreground which is problematic.
  - Experiments with oblique images (e.g. from high mountains) didn't yield good results.
- And what about imagery (drone) above the slopes? Penguins are sometimes nesting on slopes, do you use images from such nesting sites for your research and, if yes, what do you do in this case to improve the reliability of data?
  - Usually slopes are not that steep that it would cause a problem, but when the distance from ground to the drone changes, so does the pixel size
  - Therefore, it is important to consider the topography in the planning of the flight.
- Is there enough skilled personnel to carry out the monitoring?
  - Depending on the monitoring method; experts are needed for some methods (e.g., behaviour analysis is very challenging), for others you can train people.

## Insights from the discussion

### Questions for discussion

To stimulate discussions on the monitoring possibilities, the following questions were asked each day:

- Is relevant data already being collected, and if so, is there a need to improve this collection?
- Is there an appropriate monitoring method, and if not are there methods in other areas that could be adapted?
- What needs to happen so that data gaps can be closed?
- Who could be in charge of data collection?

## General considerations

Building on discussions on the objectives and general requirements of the monitoring system in the first workshop, a first rough outline of the monitoring concept was developed. Please see the presentation available at [https://tourism-monitoring-antarctica2.fresh-thoughts.eu/wp-content/uploads/sites/111/2023/10/WSII\\_monitoring-of-tourism-in-Antarctica\\_final.pdf](https://tourism-monitoring-antarctica2.fresh-thoughts.eu/wp-content/uploads/sites/111/2023/10/WSII_monitoring-of-tourism-in-Antarctica_final.pdf) for further information.

The aim of the monitoring concept is to provide information on the potential environmental impacts of touristic and other non-governmental activities. Some participants emphasized that the concept should be applied to all visitors (including private visitation and recreational activities of station staff etc.). However, to support targeted decision-making on regulation and management of Antarctic tourism, a focus on the impacts which can be attributed to touristic and other non-governmental activities is needed. While being aware that the complex relationship between various human activities (e.g., tourism, science, fisheries, etc.) and impacts on the sensitive Antarctic environment is not easy to disentangle, this targeted approach is needed to make a meaningful contribution to enhance the protection of the Antarctic.

The remarks below represent some general reflections of the participants regarding the monitoring concept:

- Summarizing data to demonstrate change is relatively easy but explaining it (causality?) more challenging (climate change, loss of krill, recovery of whales and tourism or human presence are completely confounded, and disentangling the stressors is challenging).
- measuring (marine) impacts and cumulative impacts is really challenging but need to be considered.
- Do not look for a “smoking gun”, but try to understand cumulative impacts by identifying different clusters of pressures.
- A precautionary approach is needed: focus on understanding pressures and the relationship between pressures and impacts instead of looking at impacts which have a complex causality of various Drivers (this will never result in a meaningful policy!); Pressure monitoring could be improved by going beyond just looking at the number of visitors.
- Long-time period needed for monitoring, so it could be too late to intervene, but: comparative (manipulative) studies could help to understand dynamic change influenced by multiple stressors and get to information more rapidly: by closing some selected tourism sites and observing changes in the environment (similar to the study at Port Lockroy by the British Antarctic Survey).
- It was stated that monitoring should be direction-neutral and objective. It can provide data/information on changes in the environment, but no interpretation related to the limits of acceptable change, as this is a political decision. In the Protocol on Environmental Protection to the Antarctic Treaty there is no distinction between positive and negative impacts, but it differentiates between *impacts* and *minor, transitory changes*.
- In the past, data-led monitoring did not result in meaningful tools to assist in policy decision support → instead of just collecting data, clarity on the desired outcome is needed, to turn that into indicators/targets. If the questions are clear, it helps to know what kind of data we need and to identify gaps. This will be the most effective way to have meaningful tools for policy decision support. However, diverging interests regarding the future of Antarctic tourism could be a challenge.



- Numerous data sources already exist in Antarctica, which could be scaled up (identify indicators that work long term and can be easily replicated). However, official reporting is lacking consistency (e.g., different levels of detail). EIES is not user-friendly and therefore not widely used by the national competent authorities. There is no overall comprehensive framework which brings together existing monitoring approaches.
- Some parties collect information through permit application processes and PVRs, but deplore a lack of feedback (to check the assumptions made in the application process/the actual impact); One party reported that applicants fill in a Postseason review for environmental impact assessments and mitigation measures which fosters a continuous learning and improvement process.
- Database for whole Antarctic or would it yield better results if researchers coordinate their data on a smaller scale? Or maybe we need a combination of both? (as in Europe: every member state has its own national monitoring but reports to the EEA for a more complete but less detailed assessment).
- Suggestions on a baseline for monitoring:
  - Monitoring can not start from natural conditions due to ongoing human activities (e.g., whaling, fishing, tourism, National Antarctic Programs). Further, baselines are continuously shifting due to global change
  - in Biodiversity monitoring there are two main baselines: 1) before industrial revolution 2) 1970; used by the living planet index (WWF) (the living planet index has already been applied to penguins, see **Annex C**), because there is a lot of data from that point.
  - look at trajectories (direction of change?); e.g., the global biodiversity target 2010 looked at rates of loss.
  - technology is steadily improving (e.g. satellites), this creates a series of new baselines which can't be compared.
  - For the monitoring system it could also be a practicable solution to have no pre-established baseline but to use the data from the monitoring to create such a baseline.
- Focus on changes on a smaller scale (not changes caused by global environmental change) which can be connected to tourism activities, but getting the 'bigger picture' beyond local scale observations is complex.
- Simplicity is key, we cannot solve everything at once, focus on 'protecting the most for the least' and do not cause new impacts through the monitoring.
- Prioritization is needed: use a risk assessment approach, consider integrated monitoring.
- Antarctica is not part of the UN-system (due to political reasons), but: learn from existing monitoring concepts around the world, decades of experience (for example the World Conservation Monitoring Center).
- There is already much monitoring data for penguins (convenient to monitor: easy to see, on land, large colonies, ...) and levels of tourism, while for whales and krill (keystone species!) there is comparatively less data available.
- Funding is crucial; funding mechanisms to ensure that the monitoring is implemented are needed as nothing happens without funding. Presumably, there will never be enough funding for the level of monitoring that would be desirable (considering that the analysis of data is very costly, data collection alone will not be sufficient to support decision-making).
  - Problem of "Data cemetery": a lot of data is generated, but not enough funding to analyse/publish it; it doesn't end with the fieldwork.

- Data management is key: clear data management plan, standardised/comparable data formats are needed for ease of collation from different data sources.
- Frequency of monitoring: Continuously, once in a season? (→ considering that some methods (e.g., drones) also cause disturbance to wildlife).
- Standardization of data will be essential, monitoring guideline incl. methods as monitoring will be conducted by different researchers or visitors – data needs to be comparable; especially important when monitoring chemical parameters.
- Citizen science projects which involve tourists and operators in monitoring the footprint of tourism could be possible (e.g., by taking pictures of landing sites, pictures of IAATO operators are already used to support management decisions).
- Capabilities for independent monitoring in remote areas such as the Antarctic is restricted due to logistical challenges → Ships and visitors can help to gather data (self-monitoring can be robust if there is a common goal and a mechanism of *everybody watching everybody*).

### **Monitoring possibilities from distance (based on e.g. databases, PVRs, satellite data)**

All remarks which were made in regard to monitoring possibilities from distance are summarized and clustered in the following.

- satellite data is not suitable (yet) to supply high-resolution imagery; observe impacts of tourism or Drivers/Pressures, small changes are almost impossible to detect; nutrient inputs can be monitored.
- with aerial drone imagery it is possible to detect small changes (high resolution data (cm)), already used for example for monitoring changes in glaciers driven by natural and mainly anthropogenic impacts (climate change); but: you have to be in Antarctica to collect data.
- Travel reports are always subjective, can only be useful for scientific monitoring when filled in by trained and informed personnel.
- Satellite imageries: extensive work to monitor penguin colonies, resolution up to a size of a piece of paper; ATCM: UK has submitted a paper on satellite monitoring (see **Annex C**).
- Extreme ice survey: images of glaciers to detect changes over time (see **Annex C**).
- supplementing remote work with work on the ground is important to have multiple views to understand the changes; combine different methods.
- multi-layered approach is needed for the monitoring framework; look for indicators which can be easily linked to touristic and other non-governmental activities; satellites could be used to detect trampling? Or to monitor how the landing sites changes during the season?
- Penguin numbers are less suitable for monitoring: difference of numbers cannot be associated just with tourism activities (→ clear correlations between tourism and penguin population dynamics haven't been detected so far, but this doesn't necessarily mean that there is no impact); Impacts during Covid around "Port Lockroy"; analysis will be extended to other sites and there may be local impacts at other sites.
- IAATO encourages operators to maintain a strong relationship to their National Competent Authorities; information reported in the PVRs could be a valuable data source.

## Monitoring possibilities via ship

All remarks which were made in regard to monitoring possibilities via cruise ship are summarized and clustered in the following. Please see the presentation available at <https://tourism-monitoring-antarctica2.fresh-thoughts.eu/materials/> for further information on potential pressures and impacts related to cruise ships.

- passive monitoring can be implemented on ships: automated Telemetry (“Ferry boxes”) for oceanographic monitoring (monitor pollution, environmental change, ...); see also the Southern Ocean Observing System.
- observational information can form the basis for the monitoring, e.g. observing particular taxa.
- early indicators for environmental change can be gathered from the water (e.g., microplastic); Project “Nautilus” (<https://www.nautilus-project.eu/>) looks for low-tech solutions to marine pollution.
- at the last IAATO meeting a science support working group was founded (to provide assistance to IAATO in developing a mechanism to aggregate information on the scientific work that’s being performed).
- biofouling: IMO regulations, IAATO works together with COMNAP, discussions on how to monitor biofouling.
- A prioritization of pressures is needed (focus on Pressures/Impacts which can be related to the touristic and other non-governmental activities directly; for example under the IMO Polar Code, ballast water exchange is not allowed for cruise vessels and there are strict guidelines for littering (12 miles off land); anchoring is becoming less important as a Pressure, as a lot of the newer vessels use dynamic positioning, no need to drop an anchor) → consider the current framework, e.g. existing regulations).
- IAATO participating in Marine debris monitoring: part of the CCAMLR marine debris programme (monitoring of fishing debris) (see **Annex C**)
- IAATO operators report whale strikes to the IWC.
- polyaromatic hydrocarbons could be added as a good indicator of anthropogenic pollution (originating from fossil fuel combustion or other petrogenic sources).
- some IAATO operators support research on whales around the Antarctic Peninsula, one project focused on orcas.
- program VCAPS: *voluntary cetacean and pinniped sighting program* to understand where the population is present across multiple species, expand the work from Happy Whale and help to make management decisions e.g., as a result two new geofence zones were added and the timing of one geofence zone was extended (but: these projects don’t measure abundance, only presence).

## Monitoring possibilities on land

All remarks which were made in regard to monitoring possibilities on land are summarized and clustered in the following. Please see the presentation available at <https://tourism-monitoring-antarctica2.fresh-thoughts.eu/materials/> for further information on potential pressures and impacts related to land-based tourism activities.

- Use of crowd-sourced photos to examine geological features (approach could be also helpful for environmental monitoring, e.g. monitoring change over time at landing sites)
- Cameras to observe penguin populations (e.g. time series cameras monitoring penguin and shag colonies around Scotia Arc; result: breeding has advanced by 10-14 days over the last 10 years).
- Scaling up local monitoring methods (like cameras monitoring Penguin) to survey most/all touristic landing sites could be possible.
- Monitoring of changes in penguin colonies: Install a remote camera, can be complemented with data from drones (then only one drone flight is needed); important to link the time/date to the breeding phenology.
- Drones could be suitable for long-term monitoring, but if the extend of the object is changing (e.g., penguin colony is moving), this needs to be considered in the planning and adjusted in the field, or work with a buffer zone (but: consider that the recreational use of drones by tourists is restricted by IAATO/tour operators).
- Gather data on the number of bio-invasive vectors.
- Recent research on microplastics was supported by an IAATO land-based operator (preprint paper available, **see Annex C**), there are already some citizen science projects on microplastic that could be adopted to the Antarctic (e.g., The Big Microplastic Survey (<https://microplasticsurvey.org/>), Mapping Microplastics (<https://www.mappingmicroplastics.org/>), or PlastiX-Snow (<https://www.authorea.com/doi/full/10.1002/essoar.10505938.1>)).
- understanding better where visitors go (e.g., Viking is currently re-tasking the monitoring used for tracking proximity during COVID).
- Important to consider that even if less tourists participate in land-based tourism, the impact (per capita) could be comparatively higher.
- Pilot project in South Georgia/the South Sandwich Islands: operators fill out a checklist & take photos of the landing site to track the impact from tourism (e.g., invasive species) → positive feedback and good uptake so far; takes only 10 min.

## Annex A: List of participants

	Name	Surname	Institution
1	Alfonsina	Macías	INOCAR
2	Allison	Cusick	Scripps Institution of Oceanography
3	Allison	Kean	Government of South Georgia and the South Sandwich Islands
4	Amanda	Lynnes	IAATO
5	Andrew	Titmus	National Science Foundation
6	Anisja	Obermann	Wageningen University & Research
7	Anna M.	Fioretti	Institute of Polar Sciences (CNR)
8	Anne	Stoltenberg	Ministry of Climate and Environment
9	Annette	Bombosch	The Polar Citizen Science Collective
10	Atilla	YILMAZ	TÜBİTAK MAM Polar Research Institute
11	Birgit	Njaastad	Norwegian Polar Institute
12	Claire	Waluda	British Antarctic Survey
13	Damon	Stanwell-Smith	Viking
14	Daniela	Cajiao	SCAR
15	David	Taillefer	Environment and Climate Change Canada
16	Doğaç Baybars	İŞILER	Polar Research Institute, TUBITAK MAM
17	Elizabeth	Leane	University of Tasmania
18	Franziska	Lotter	Fresh Thoughts Consulting GmbH
19	George	Clarkson	FCDO
20	Gina	Selig	NSF
21	Gina	Greer	IAATO
22	Hanna	Yevchun	State Institution National Antarctic Scientific Center
23	Hanne	Nielsen	University of Tasmania / Institute for Marine and Antarctic Studies
24	Heike	Herata	German Environment Agency
25	Hyungjoon	Kim	Korea Polar Research Institute
26	Jasmine	Lee	British Antarctic Survey
27	Julie	Roemele	U.S. Environmental Protection Agency

	Name	Surname	Institution
28	Kevin	Hughes	British Antarctic Survey
29	Küster	Anette	Umweltbundesamt
30	Lisa	Kelley	IAATO
31	Michael	Dartsch	Plantours Kreuzfahrten
32	Michaela	Matauschek	Fresh Thoughts Consulting GmbH
33	Michaela	Dr. Mayer	INASEA
34	Nancy	Sung	NSF
35	Nils	Vanstappen	Federal Public Service Health
36	Osama	Mustafa	ThINK - Thüringer Institut für Nachhaltigkeit und Klimaschutz GmbH
37	Pablo	Tejedo	Universidad Autónoma de Madrid
38	Polly	Penhale	National Science Foundation
39	Rachel	Clarke	British Antarctic Survey
40	Ricardo	Roura	Antarctic and Southern Ocean Coalition (ASOC)
41	Rita	Fabris	German Environment Agency
42	Sherrie-lee	Evans	University of Tasmania
43	Stephanie	Keast	Environment and Climate Change Canada
44	Thomas	Dworak	Fresh Thoughts Consulting GmbH
45	Tom	Hart	Oxford Brookes University
46	Yu-Fai	Leung	North Carolina State University
47	Zena	Wright	Environment and Climate Change Canada

## Annex B: Agenda

### Day 1: Monitoring possibilities from distance (based on e.g. databases, PVRs or satellite data)

10 October 2023 (online), 13:00 - 16:00 CEST

Time	Session
13.00-13.10	<b>Welcome</b> <b>Short introduction to the Project “Tourism monitoring in Antarctica”</b> <i>German Environment Agency (UBA)</i>
13.10-13.15	<b>Overview of the workshop (objectives, time plan)</b> <i>Fresh Thoughts Consulting</i>
13.15-13.25	<b>Short round of introduction</b>
13.25-14.00	<b>Presentation of the status of the monitoring concept (incl. gaps and challenges)</b> <b>Q &amp; A</b> <i>Fresh Thoughts Consulting</i>
14.00-15.20	<b>Introduction</b> <i>Fresh Thoughts Consulting</i> <b>Short break</b> <b>Parallel working groups</b>
15.20-15.30	<b>Break</b>
15.30-16.00	<b>Reflection on the results from the working groups</b> <i>German Environment Agency (UBA), Fresh Thoughts Consulting, INASEA</i> <b>Outlook for Day 2</b> <i>Fresh Thoughts Consulting</i>

### Day 2: Monitoring possibilities via ship

11 October 2023 (online), 13:00 - 16:00 CEST

Time	Session
13.00-13.15	<b>Welcome back</b> <b>Overview of the workshop (objectives, time plan) and report back from the day before</b> <i>Fresh Thoughts Consulting</i>
13.15-14.00	<b>Keynote: Using citizen science projects for monitoring – experiences from practical examples</b> <b>Q &amp; A</b> <i>Annette Bombosch, Polar Citizen Science Collective</i>
14.00-15.20	<b>Introduction</b> <i>Fresh Thoughts Consulting</i>

Time	Session
	<b>Short break</b> <b>Parallel working groups</b>
15.20-15.30	<b>Break</b>
15.30-16.00	<b>Reflection on the results from the working groups</b> <i>German Environment Agency (UBA), Fresh Thoughts Consulting, INASEA</i> <b>Outlook for Day 3</b> <i>Fresh Thoughts Consulting</i>

### Day 3: Monitoring possibilities on land

12 October 2023 (online), 13:00 - 16:00 CEST

Time	Session
13.00-13.15	<b>Welcome back</b> <b>Overview of the workshop (objectives, time plan) and report back from the day before</b> <i>Fresh Thoughts Consulting</i>
13.15-14.00	<b>Keynote: Possible field methods to monitor tourism impact on the Antarctic environment</b> <b>Q &amp; A</b> <i>Osama Mustafa, THINK - Thuringian Institute of Sustainability and Climate Protection</i>
14.00-15.20	<b>Introduction</b> <i>Fresh Thoughts Consulting</i> <b>Short break</b> <b>Parallel working groups</b>
15.20-15.30	<b>Break</b>
15.30-16.00	<b>Reflection on the results from the working groups</b> <i>German Environment Agency (UBA), Fresh Thoughts Consulting, INASEA</i> <b>Any other business</b> <b>Next steps</b> <i>German Environment Agency (UBA)</i>



## Annex C: Recommended readings and useful links provided by participants

The section below provides references to scientific papers, reports and projects which were recommended to be considered in the development of the monitoring concept.

### Scientific papers and reports:

- ▶ ATCM XLV Working Paper 41 (Monitoring the impacts of human activity in Antarctica): [https://documents.ats.aq/ATCM45/wp/ATCM45\\_wp041\\_e.docx](https://documents.ats.aq/ATCM45/wp/ATCM45_wp041_e.docx)
- ▶ Penguindex: a Living Planet Index for Pygoscelis species penguins identifies key eras of population change: <https://link.springer.com/article/10.1007/s00300-023-03148-2>
- ▶ Drone disturbance experiments:
  - State of knowledge: Antarctic wildlife response to unmanned aerial systems: <https://doi.org/10.1007/s00300-018-2363-9>
  - Emperor Penguin Reactions to UAVs: First Observations and Comparisons with Effects of Human Approach: <https://doi.org/10.1016/j.rsase.2021.100545>
  - Measuring the Influence of Unmanned Aerial Vehicles on Adélie Penguins: <https://doi.org/10.1007/s00300-015-1838-1>
  - Sensitivity of Adélie and Gentoo Penguins to Various Flight Activities of a Micro UAV: <https://doi.org/10.1007/s00300-018-2385-3>
  - Effects of UAV Overflight Height, UAV Type, and Season on the Behaviour of Emperor Penguin Adults and Chicks: <https://doi.org/10.1016/j.rsase.2021.100558>
- ▶ Microplastics in Antarctica - a Plastic Legacy in the Antarctic Snow? (preprint) <https://doi.org/10.21203/rs.3.rs-3389603/v1>

### Existing monitoring approaches/project:

- ▶ Happywhale (citizen science project): <https://happywhale.com/home>
- ▶ The Polar Citizen Science Collective: <https://polarcollective.org/there>
- ▶ Penguin Watch (citizen science project): <https://www.zooniverse.org/projects/penguintom79/penguin-watch>
- ▶ Extreme Ice Survey: <http://extremeicesurvey.org/>
- ▶ UNEP World Conservation Monitoring Centre: <https://www.unep-wcmc.org/en>
- ▶ Southern Ocean Observing System: <https://soos.aq/>
- ▶ CCAMLR Marine Debris program: <https://www.ccamlr.org/en/science/marine-debris>
- ▶ Reporting of whale strikes: <https://portal.iwc.int/>

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## Imprint

### Publisher

Umweltbundesamt  
Wörlitzer Platz 1  
06844 Dessau-Roßlau  
Tel: +49 340-2103-0  
Fax: +49 340-2103-2285  
[buergerservice@uba.de](mailto:buergerservice@uba.de)  
Internet: [www.umweltbundesamt.de](http://www.umweltbundesamt.de)  
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### Authors, Institutions:

Franziska Lotter, Thomas Dworak  
Fresh Thoughts Consulting GmbH  
Hütteldorferstraße 215/29  
1140 Vienna  
Austria

Dr. Michaela Mayer  
INASEA  
Kirchlintelner Str. 3  
28325 Bremen  
Germany

**Completion:** November 2023